INCREASE LGE-KU SOLAR TO 4,200MW CAPACITY THIS DECADE

The Least Cost Option in the Long-Term

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PUBLIC SERVICE COMMISSION

Commissioners Chandler, Hatton, and Regan,

First, my apologies for the explanatory nature that runs through these comments, but it is only to better secure an understanding for those of us, including myself, who are trying to grasp the full impact of this case and hopefully for those who choose to only see a business perspective in spite of the preponderance of facts that greatly impact Kentucky's citizens.

Summary

LGE-KU (the Companies) have filed case 2022-00402 requesting approval to close three electric generation coal units and replace them with a small amount of photovoltaic solar **(PV Solar)**, one battery storage unit and two **new gas-fired turbines**. I filed comments in April with the PSC suggesting you deny the natural gas (NG) turbines and increase the solar generation to 4,200MW, five times what the Companies have proposed. That request was based primarily on a "study" the Companies' own parent company, PPL, did in 2022 showing 4,200MW of PV Solar generation was viable without additional battery storage.[1] My comments also pointed out that Kentucky is last among all states in solar and wind renewable generation. It suggested, if the Companies still think PV Solar is not feasible, the commissioners restore the original, 1:1 net metering for the Kentuckians and solar installers that think it is feasible. The comments showed the impacts of climate change are not somewhere off in a distant future but happening both locally and globally every day, it is well documented that such events will only grow worse, and there is still time to mitigate the costly, growing consequences if we significantly reduce our use of fossil fuels.

This second paper challenges the Companies' gas turbine least-cost option claims and that they have considered a wide range of options. This criterion is based on PSC CPCN filings of "least-cost" option, over the "long-term" and that the filing utility show they "considered a wide-range of options". One of these options would reasonably be PPL's study showing the viability of a generation portfolio containing 4,200MW of PV Solar.

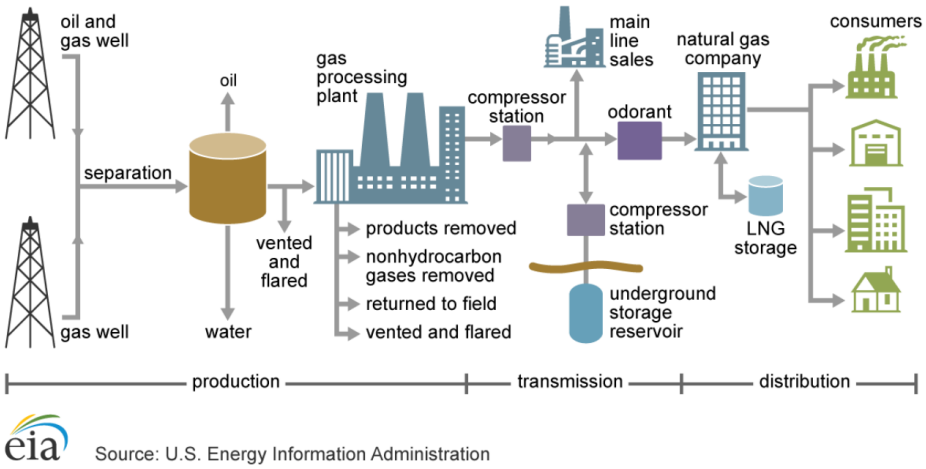
- This paper will show by comparing the two processes, PV Solar in its simplicity is a cheaper option than NG generation especially when carbon capture and sequestration (CCS) is included. It will show NG generation with CCS is LGE-KU's strategy to attain net-zero by 2050, they have been working on CCS for 20 years and have announced this March a CCS pilot program for their Cane Run NG generator.
- This paper will show record high NG consumption and residential price rates for the US and especially Kentucky, that a NG future will continue to be price volatile, while PV Solar prices are dropping globally.
- This paper questions the LGE-KU assertion that new NG generation is necessary and wonders if the Companies even considered building the 4,200MW, instead of the proposed 877MW, as one of the wide-range of options.
- The paper will also question the use of NG at all, showing NG fugitive emissions (FUEMS) throughout the NG processing system, including the Doe Run gas reservoir that LGE was forced to retire due to shocking FUEMS losses.

[1] https://www.pplweb.com/wp-content/uploads/2022/12/PPL_Corp-2022-Generation-Study-FINAL.pdf p. 8

- Lastly, attribution science is becoming better at determining whether severe weather events can be attributed to climate change and, if so, to what degree. We ignore this information at our own risk.

Does Kentucky Need More PV Solar or More Natural Gas Power Generation?

Referencing the diagrams of NG and PV Solar electric generation, it can be seen there are a number of ongoing processes with NG production, transmission, and distribution, before it is ever used to generate electricity - represented by the green smokestacks. Each of these processes are known to emit FUEMS to varying degrees.



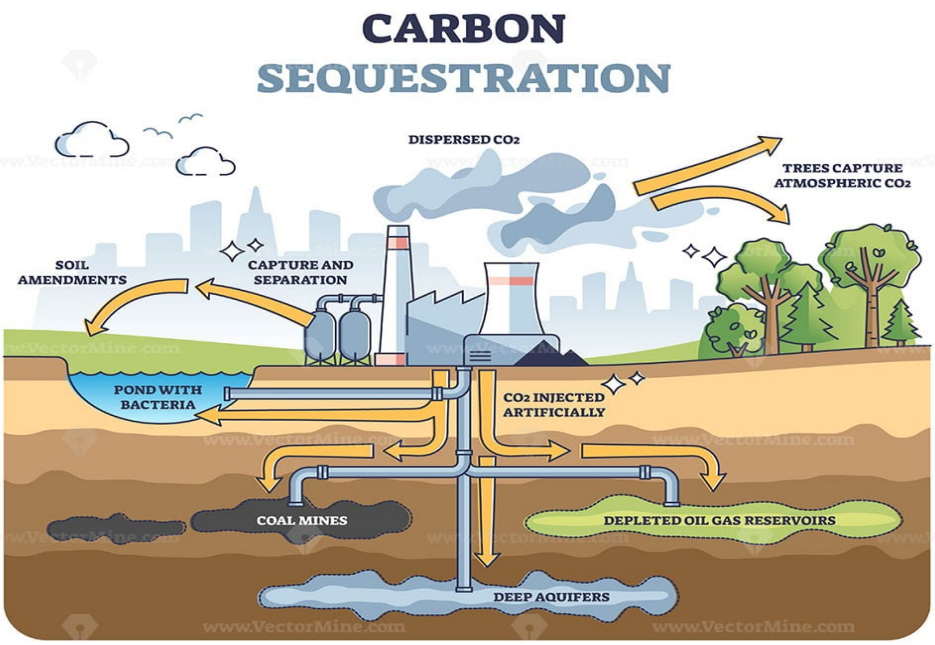
In addition, the carbon emitted during NG combustion will require ongoing separation, capture, and transmission to a CCS facility. At this date, CCS technology has significant technical, social, environmental and costs hurdles. Yet, LGE-KU's CCS **pilot** program for the Cane Run gas fired-turbine was announced in March of this year.[2] That LGE-KU has announced this pilot for **unproven** CCS technology now and has acquired estimates to build enough NG pipeline capacity for three NG turbines at Mill Creek raises questions as to this long-term gamble on NG. If CCS is ever brought to full-scale, these monthly costs will also be passed on to rate payers.

March 31, 2023 - "As part of our commitment to achieve net-zero carbon emissions by 2050, decarbonization technology is a key focus area for our utilities and others across the energy industry with similar goals," said LG&E and KU President John R. Crockett. "We've been involved in leading carbon capture research for nearly 20 years and believe the experience we bring, along with our partners' innovation, will play a critical role in advancing this technology."

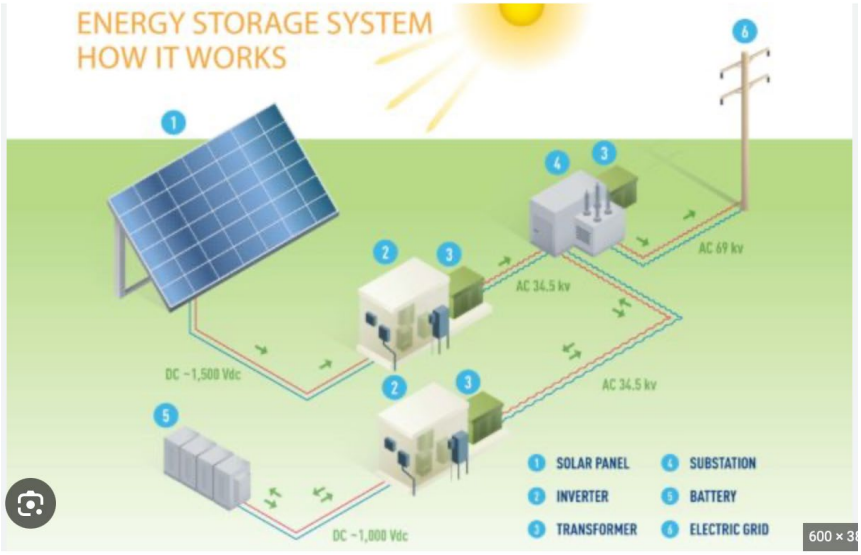
Have the Companies been leading in PV Solar research for 20 years?

What happens to the CO_2 emissions after they is captured?
Some emissions are piped into abandoned NG reservoirs, coal mines or aquifers, compressed and frozen into a liquid or transported (also refrigerated?) to a company that can use some of it for commercial purposes. These are more processes that require additional costly daily energy and distribution infrastructure. **How often have we seen that the man made cure is worse and more costly than the problem?**

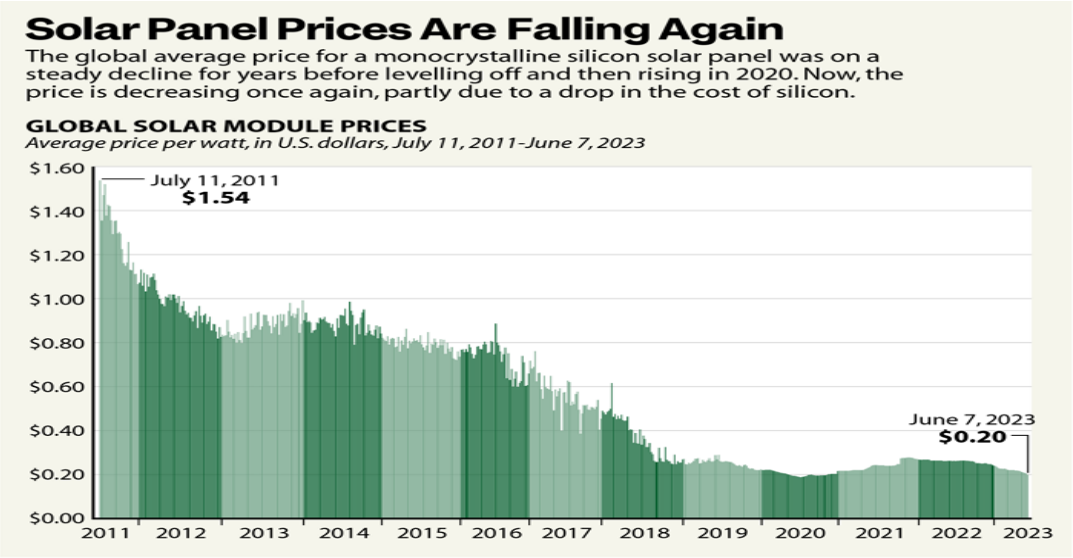
[2] https://news.pplweb.com/2023-03-31-LG-E-and-KU,-EPRI,-University-of-Kentucky,-begin-industry-leading-research



By contrast, solar generation has no costly fuel, fuel processes or carbon dioxide and methane emitting processes. Once installed, solar requires minimal maintenance and leasing the land it sits on, if necessary, is the only ongoing cost. All processes of electricity generation are handled by the sun – for free. As solar is increased beyond 4,200MW, battery storage and other **proven** storage technologies can be added to supplement nights and cloudy days when electricity demand is required.



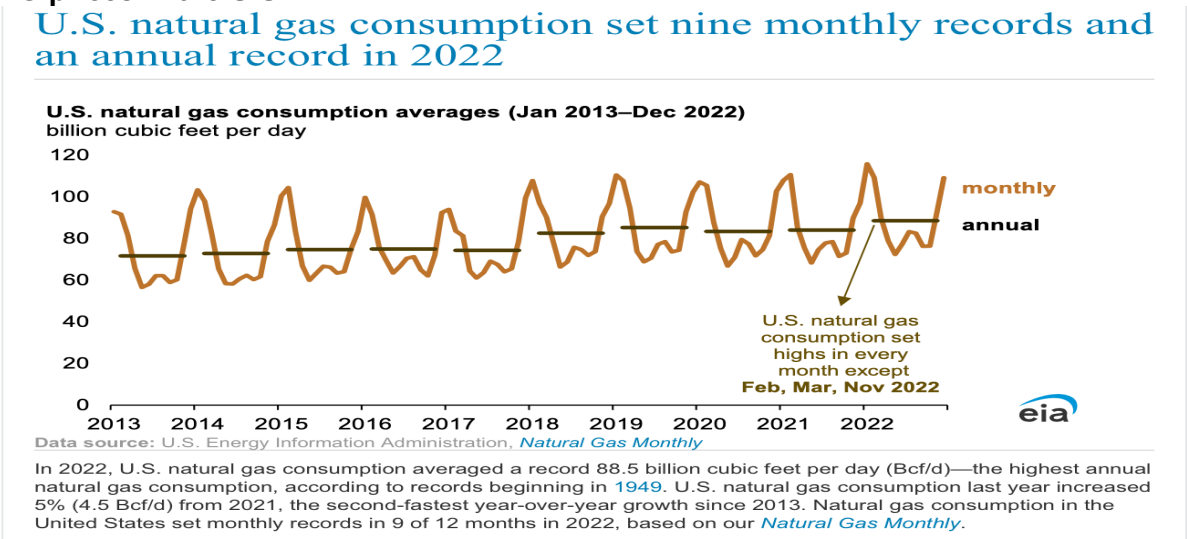
And, though it is predicted there will be some lag time before the U.S. sees the full impact of these global price drops, solar panel prices are coming down as shown below.



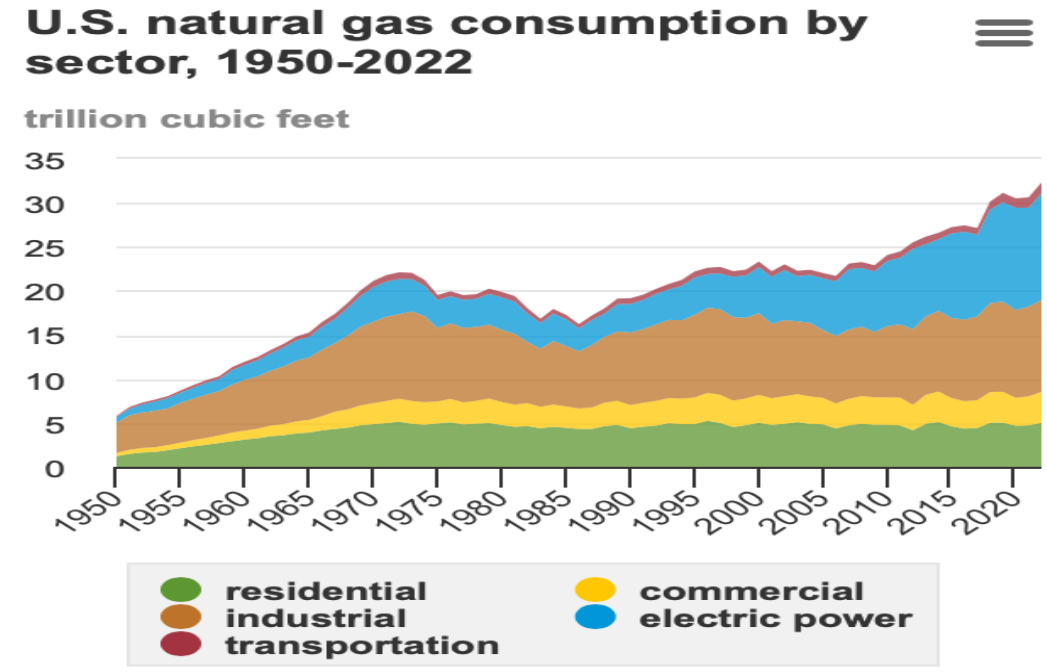
Have the Companies considered in their wide range of options these NG processes compared to the cost for PV Solar ?

Rising Consumption of Natural Gas

The charts below show that U.S. NG consumption broke 9 monthly and 1 annual consumption record in the US in 2022 driven mostly by an increase in electric power generation. Though prices as well hit a high in 2022 the EIA predicts in most scenarios that prices will drop from these highs through 2050. **But what does this volatile NG industry mean for Kentucky who already has some of the highest NG prices in the U.S.?**

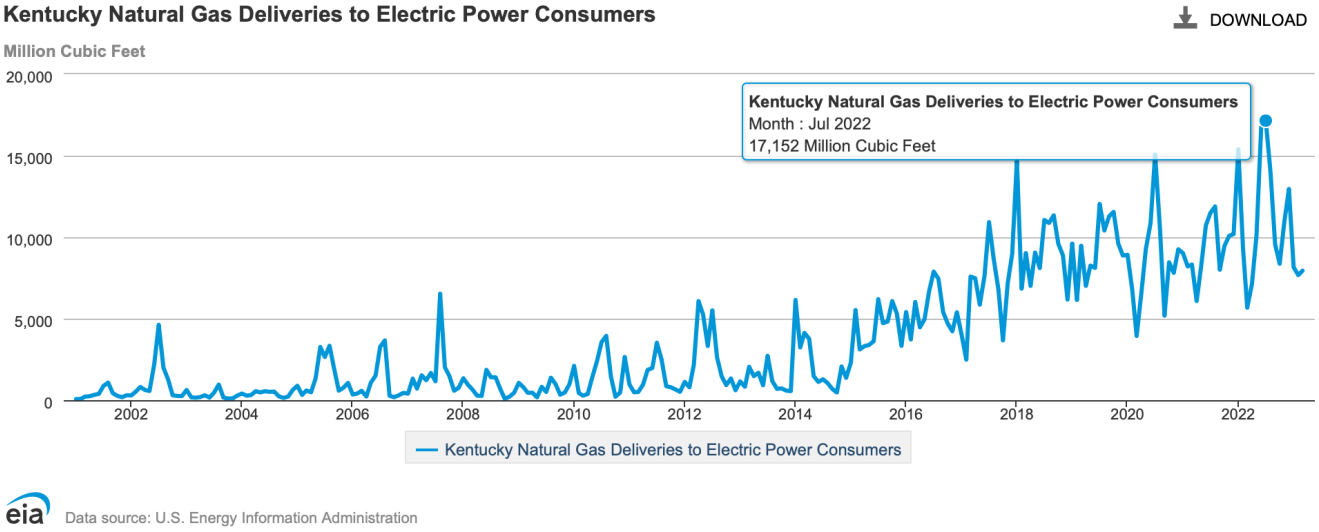


Natural gas electricity generation (electric power) rose above all sectors and accounted for more than 1/3 of all natural gas consumption in the US.



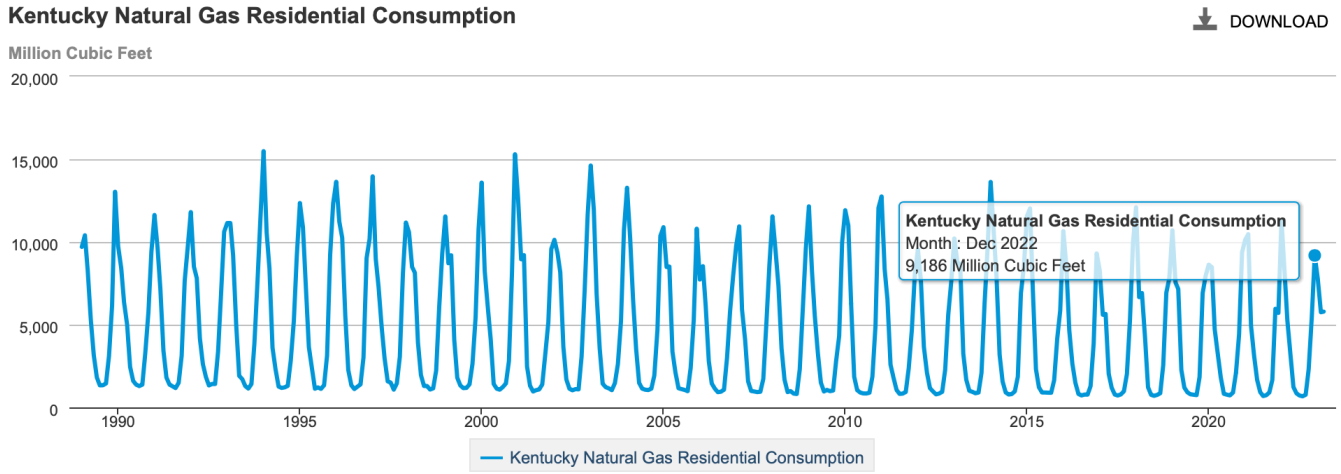
Data source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 4.3, April 2023; preliminary data for 2022

Note: Transportation includes pipeline and distribution use and vehicle fuel.

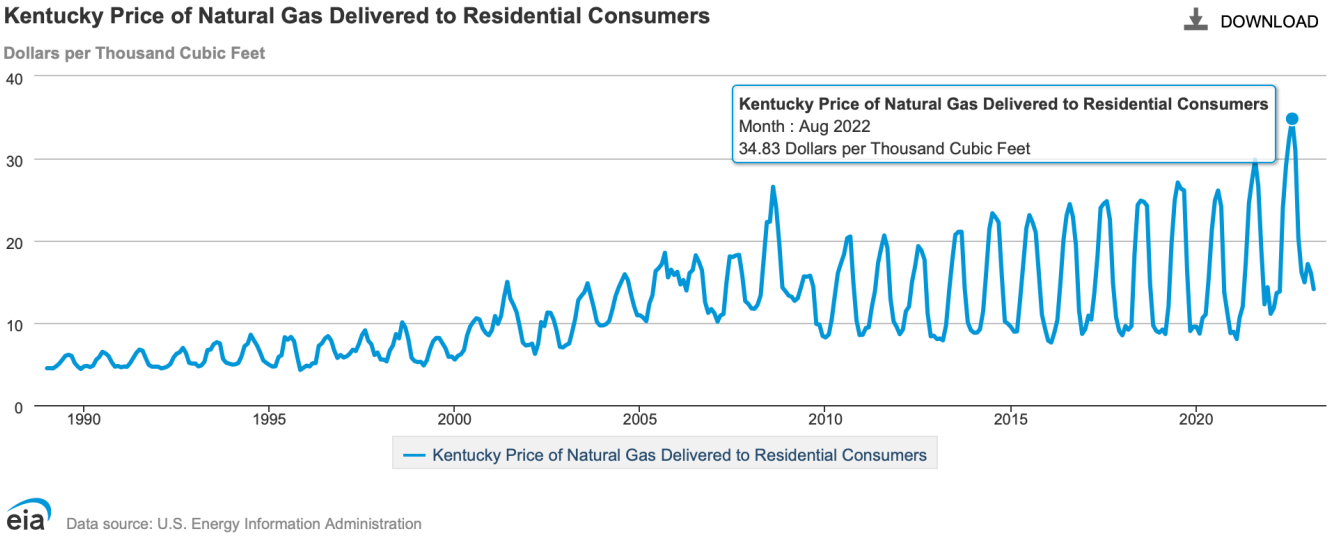


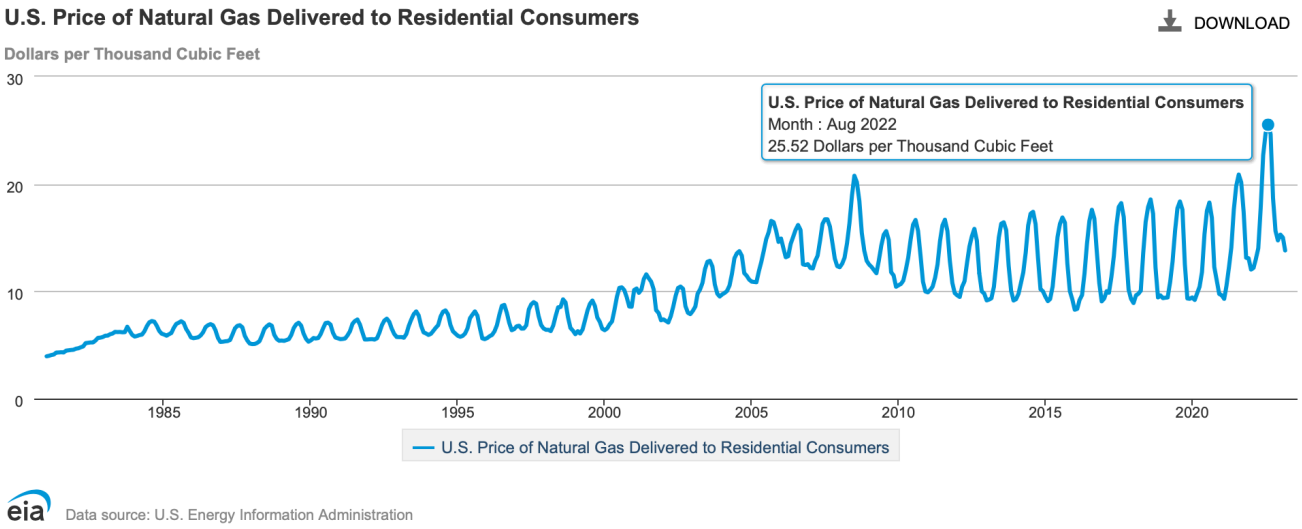
Data source: U.S. Energy Information Administration

NG consumption for **electric power** generation surpassed **residential** peak consumption for heat in 2018. Though it has hovered consistently around its peak of 10Bcf in the winter, three of the lowest residential peaks were over the last 7 years.



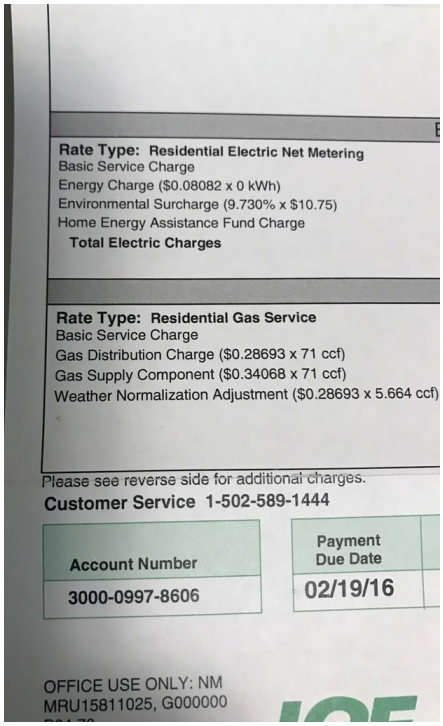
Yet Kentuckians, who have been paying higher gas prices than the US average since the early 2000's, paid a record high of $34.83/1000cf in 2022, 36% more than the US average.





Can the Companies explain this 36% difference in the Kentucky and U.S. prices? Can the Companies explain why prices have been so much higher to start with?

LGE residential NG supply prices in Louisville reached a record $.98ccf in January 2023. Over the same period, distribution costs have incrementally increased by 80%.

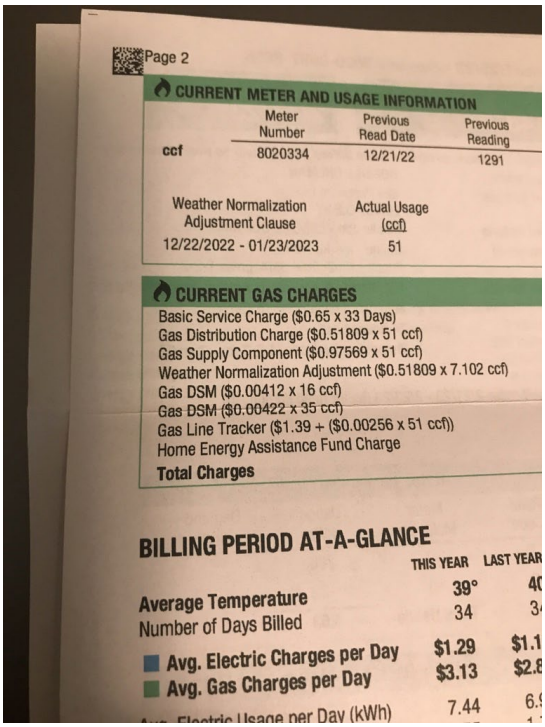


LGE January Gas Bills
2016 vs 2023

Supply
$.340 vs $.975

Distribution
$.287 vs $.518

In 7 Years,
a 186% increase
for "Supply" cost, and a
80% increase
for "Distribution" costs.



Have the Companies considered these recent rises in consumption and cost of NG?

Is increased pipeline infrastructure, replacement, and maintenance the reason for rising residential, commercial and industrial, NG distribution prices?

Increasing PV Solar to 4,200MW Instead of 877MW

The PPL Study analyzed the feasibility of employing 80% renewable energy by 2030.[3] The yearly plan charted by PPL in Fig A4 below was considered "unfeasible" on four points given the cost and time frame allotted. These are, 1) unprecedented renewable build-out resulting in overbuild, 2) the need for significant storage capabilities to capture overbuild, 3) the use of 250,000 acres for PV panels, and 4) extensive transmission upgrades. Yes, if LGE-KU is ever going to fully embrace renewable solar, these things to a degree will be required and should have been planned for years ago to achieve 80% by 2030. But increasing solar to 4,200MW in this decade, according to their own calculations below, does not require overbuild and storage and needs only small portions of the stated acreage and upgrades, keeping the cost and time frame feasible.

PPL CLIMATE ASSESSMENT ADDENDUM STUDY

Figure A4: LG&E and KU Generation Portfolio Transition Required to Achieve 80% Clean Energy by 2030

Year	2022A	2026		2027		2028		2029		2030	
Clean Energy Target	N/A	20%		35%		50%		65%		80%	
Capacity/Energy	MW	MW	TWh	MW	TWh	MW	TWh	MW	TWh	MW	TWh
Summer Peak Demand	6,187	6,282	32.9	6,376	33.7	6,382	33.7	6,385	33.6	6,397	33.4
Coal	4,889	4,589	21.1	4,292	17.2	3,416	13.2	1,571	6.9	0	0.0
Gas	2,716	2,698	5.3	2,698	4.7	2,698	3.7	2,698	4.8	3,211	6.7
Solar	12	2,602	6.2	4,207	10.0	4,207	10.0	6,636	15.8	9,343	22.3
Wind	0	0	0.0	706	1.8	3,286	8.7	3,771	9.8	4,372	11.4
Hydro	134	134	0.4	134	0.4	134	0.4	134	0.4	134	0.4
Battery Storage (8-hour)	0	0	0.0	0	0.0	29	0.1	1,749	5.0	3,735	11.8
Unused Solar/Wind			0.0		-0.5		-2.2		-3.5		-5.7
Battery/Inverter Losses			0.0		0.0		0.0		-0.7		-1.7

Figure A4 illustrates the aggressive and unprecedented growth in renewable energy that would need to be sited and built this decade to achieve an 80% clean energy target by 2030. In this scenario, all coal units would be forced to retire by 2030. Unused solar/wind represents curtailed energy as overbuild is required to meet 24/7 energy demands. Battery/inverter losses represents loss of energy in the charging and discharging process. PPL used a generation portfolio optimization model to estimate the least-cost generation portfolio for meeting an 80% clean energy standard by 2030.

How does the research in PV Solar at EW Brown compare with the complete cycle of NG processes, including CCS?

Have LGE-KU considered purchasing or leasing the necessary land for 4,200MW of solar now, then buying solar panels in a couple of years as the costs fall in the U.S.?

Have the Companies considered putting the gas turbine at Cane Run and using the full 600 acres at Mill Creek for PV Solar?

[3] https://www.pplweb.com/wp-content/uploads/2022/12/PPL_Corp-2022-Generation-Study-FINAL.pdf p. 8

Case Filing 2023-00089 Doe Run Natural Gas Storage Retirement

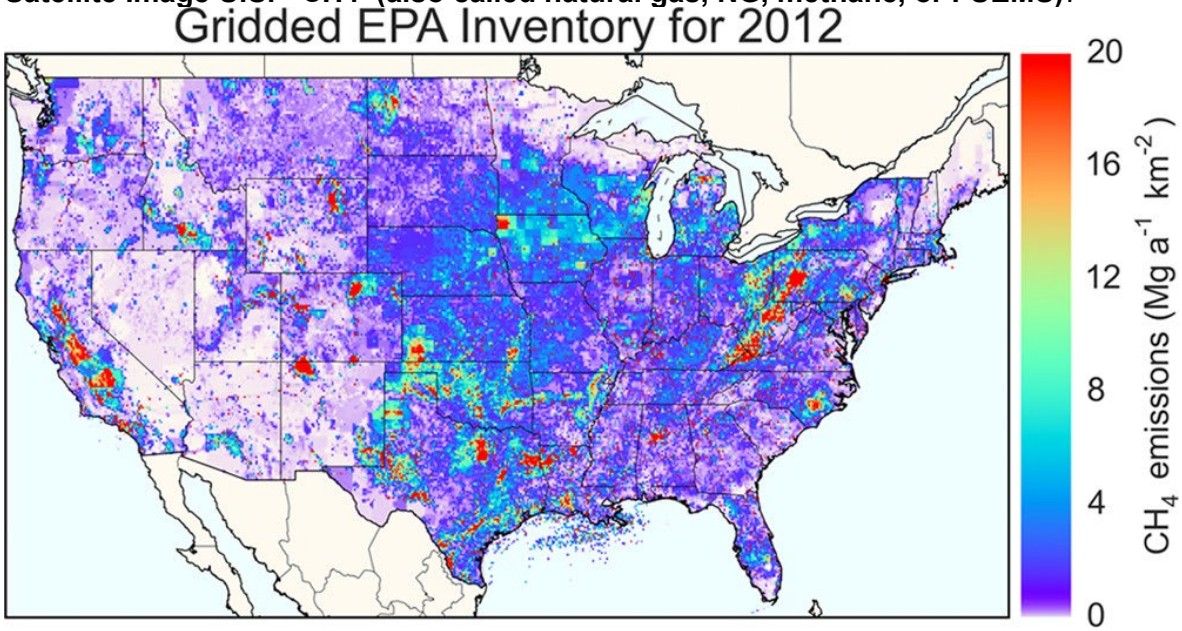
NG storage, distribution and power generation is an inherently GHG polluting process as methane has 30 times the climate change impact of CO_2. The EPA estimates 2020 U.S. NG FUEMS accounted for 211MMtCO_{2e}. The largest portion, 41%, of these FUEMS came from NG production and the next highest, 19%, came from transmission and storage - all before ever reaching the power plant for combustion.[4] This is well demonstrated by LGE's Doe Run storage facility in Meade County.

This former NG well and current NG storage facility is 13,800 acres in area and runs under the Ohio River into Harrison County Indiana. Despite LGE's awareness of it leaking NG since at least 2005, LGE continued to use this faulty container until it was no longer profitable stating in KPSC case 2023-00089, *"Since 2005, [Doe Run] annual natural gas loss volumes have steadily increased from 295,000 Mcf to current levels of 500,000 Mcf. Current gas loss volumes represent approximately 20% of the annual volume of cycled working gas. In addition to gas losses, the gas withdrawn from Doe Run contains hydrogen sulfide (H2S) and moisture resulting in a potential corrosive environment for storage field piping. Recent Doe Run piping failures resulting from internal corrosion highlighted the operational risk associated with pipe that has been subject to the corrosive constituents found in the wet gas system."* [5],

Has LGE included these past NG losses into the price rate payers paid for NG?

In addition to FUEMS, a new study by the American Chemical Society and reported by Inside Climate News[6], of 48 gas wells, including some of the 3.2 million abandoned gas wells in the US, emphasizes, *"... residents of the nation's fossil-fuel producing regions could be facing a different threat: carcinogens and other toxic air contaminants spewing from millions of wells that are no longer even operating.* The report goes on to say most of the studied wells were leaking and adds to the growing data that shows methane isn't the only gas in "natural gas". *"Almost every single sample of gas across the supply chain, including abandoned wells, contains cancer-causing benzene, his studies have found. But with so many abandoned wells across the country and more to come as drilling continues, he adds, it's really a multitrillion-dollar national problem." June 6, 2023 - Inside Climate News*

Satellite Image U.S. - CH4 (also called natural gas, NG, methane, or FUEMS)[7]



[4] https://www.epa.gov/natural-gas-star-program/estimates-methane-emissions-segment-united-states
[5] https://psc.ky.gov/pscecf/2023-00089/andrea.fackler@lge-ku.com/05122023081525/Closed/3_-_LGE_PSC_First_Set_of_Data_Responses_(CN_2023-00089).pdf
[6] https://insideclimatenews.org/news/06062023/abandoned-oil-gas-wells-health/?utm_source=InsideClimate+News&utm_campaign=6d5650b6d7-EMAIL_CAMPAIGN_2023_06_10_01_00&utm_medium=email&utm_term=0_29c928ffb5-6d5650b6d7-328706794
[7] https://pubs.acs.org/action/downloadCitation

Why has LGE taken until now to act on Doe Run's growing problem with leakage? Is it an effort to keep 2022-00402 new gas turbines' costs at a minimum?

Will CCS carbon be stored at Doe Run and is that safe?

What easements would be required to run the carbon pipelines?

How much pipeline will be needed to get CC to Eastern KY coal mines?

What will Eastern Kentucky communities have to say about having CO_2 stored in abandoned coal mines? Is that safe?

Is the nearby Muldraugh storage reservoir, opened a few years after Doe Run (1928), also leaking?

What about the other 3 reservoirs opened in the 50's and 60's – Magnolia Upper, Magnolia Deep, and Center?

Where will the carbon from the other new gas turbine at Ghent be stored?

Climate Change and Attribution Science

Attribution Science evaluates severe weather events as to whether or not they can be attributed to climate change and if so, to what degree. *"One of the first climate attribution studies to be widely cited by other scientists was published in 2004, in Nature."* This study came after the heat waves in Europe and interest grew considerably after Super Storm Sandy. Scientists have completed hundreds of attribution science studies since 2004. Advances in technology have made it easier to isolate climate's role.

"Climate change worsened excessive heat 93 percent of the time, drought 69 percent of the time, and rain or flooding 56 percent of the time." "It's [World Weather Attribution - WWA[8]] study of the 2019-2020 Australian brush fires concluded that climate change played a part in increasing the overall seasonal fire risk by a factor of nine. In 2021 an Australian court considered this result when it ruled that the New South Wales Environmental Protection Agency had failed to protect the environment,…"

In 2021, *Time* included her, WWA co-founder Frederike Otto, on the list of the worlds 100 most influential people. *Scientific American June 2023, "Blame Game – How scientists got confident attributing disastrous weather on global warming"*

A Final Note

It has not been until very recently that LGE-KU has even acknowledged climate change. Do they acknowledge their role in Kentucky's unseasonable and deadly tornadoes in December 2021 and the flooding in July 2022 in Eastern Kentucky? These events were followed by three windstorms this March and April that knocked out power to over 400,000 Kentuckians. Everything about the operation of LGE-KU's business requires keen awareness and accuracy in the use of the scientific data. The climate data, the cost of fuel, expenses for plant operation and maintenance and emissions reduction tell PPL that 4,200MW of solar is a good fit for this decade. LGE-KU executives are either not asking the right questions or are ignoring the right answers.

Now, asking the right questions of our decision makers is the job for those of us who care about this amazing planet and all of its incredible inhabitants.

[8] https://www.worldweatherattribution.org/analysis/rainfall/

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